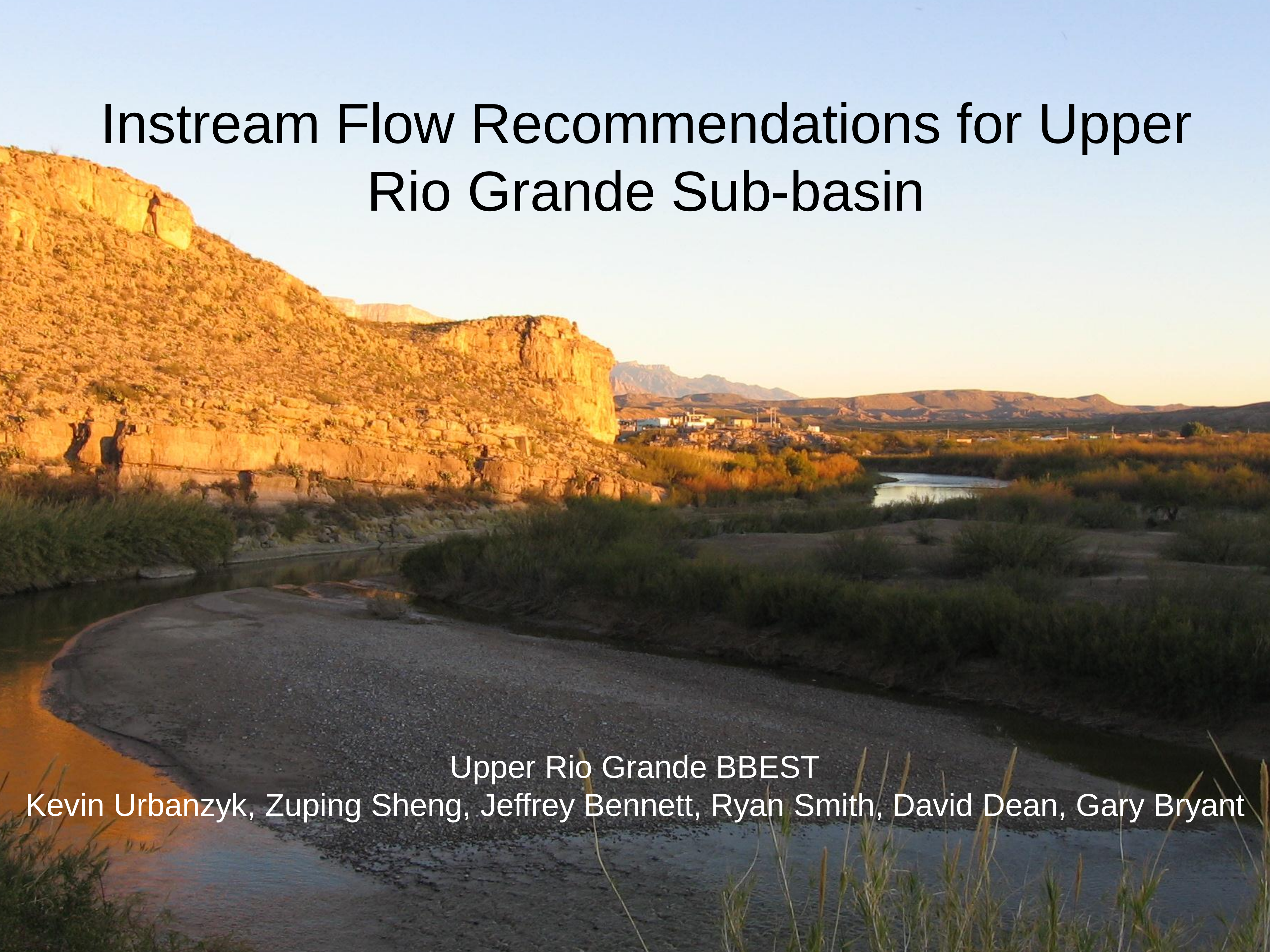
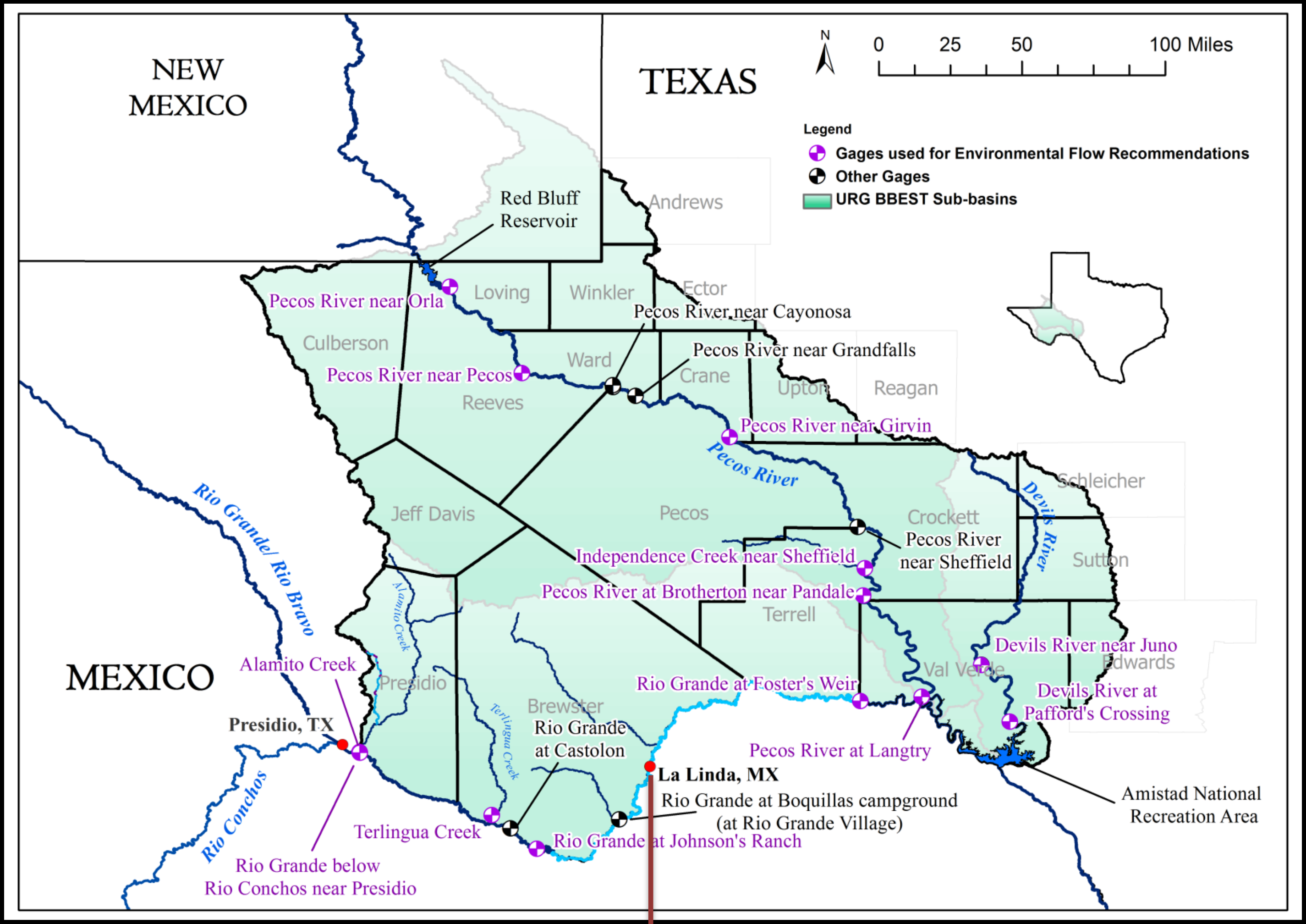


Instream Flow Recommendations for Upper Rio Grande Sub-basin

Upper Rio Grande BBEST
Kevin Urbanzyk, Zuping Sheng, Jeffrey Bennett, Ryan Smith, David Dean, Gary Bryant

Geographic Scope



Parks Reach - Unsound | Lower Canyons reach - Sound

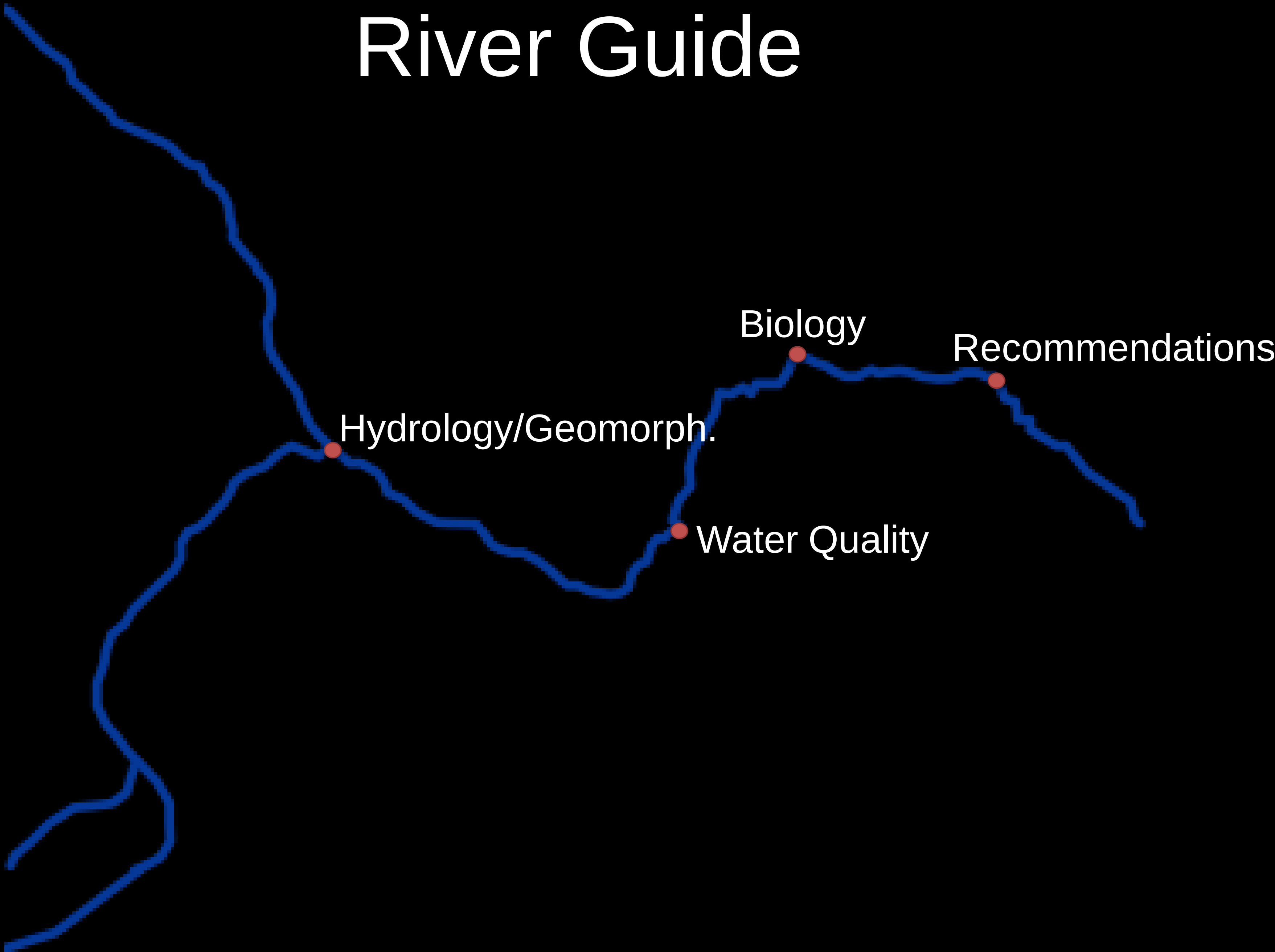
Determination of Soundness

Upstream Unsound Parks Reach	**Downstream Sound Lower Canyons Reach**
Historic hydrologic reductions	Lesser degree of hydrologic reductions
Degraded geomorphic condition	Geomorphic condition not well understood
Poor water quality	Improved water quality from groundwater inputs
Degraded aquatic habitat	Aquatic habitat deemed sufficient

For instream flow recommendations:

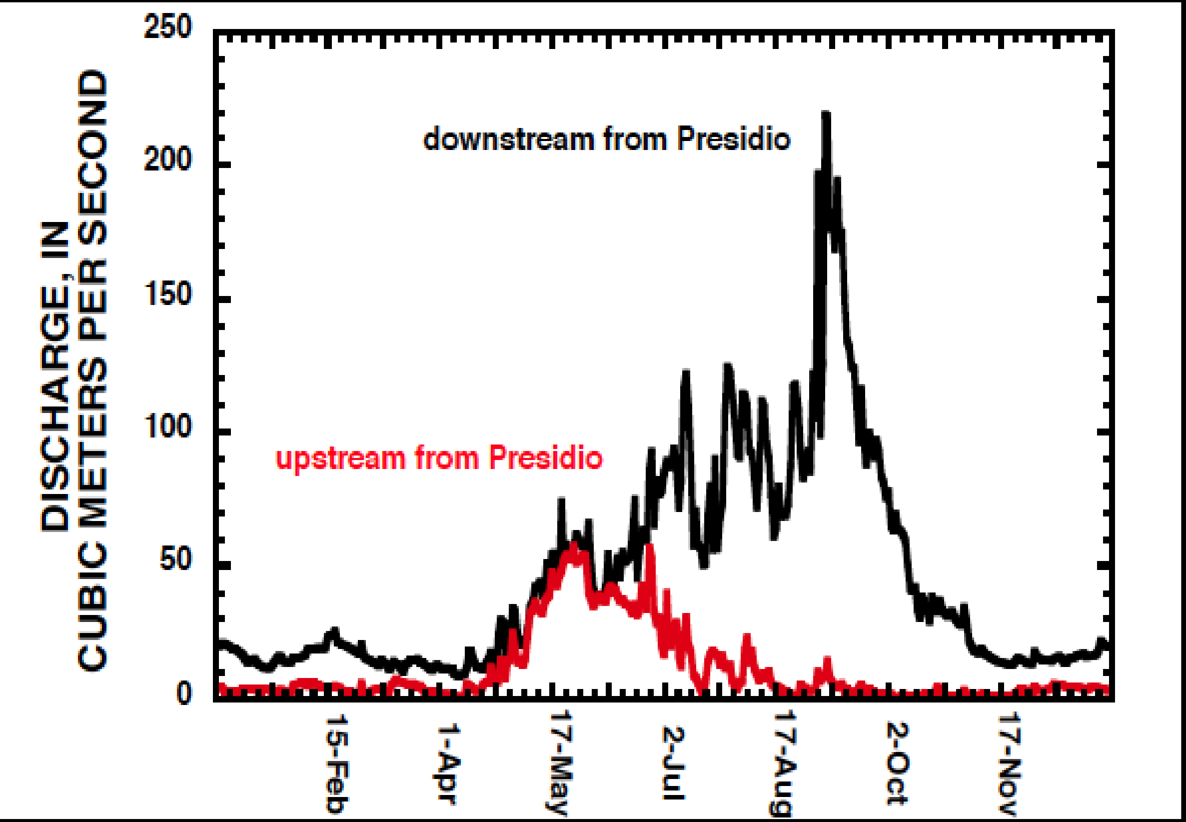
- HEFR Analyses define hydrologic characteristics,
- Geomorphology overlay to inform high flow pulse and overbank flow recommendations
- Water quality and biology overlays to inform base flow and subsistence flow recommendations.

River Guide

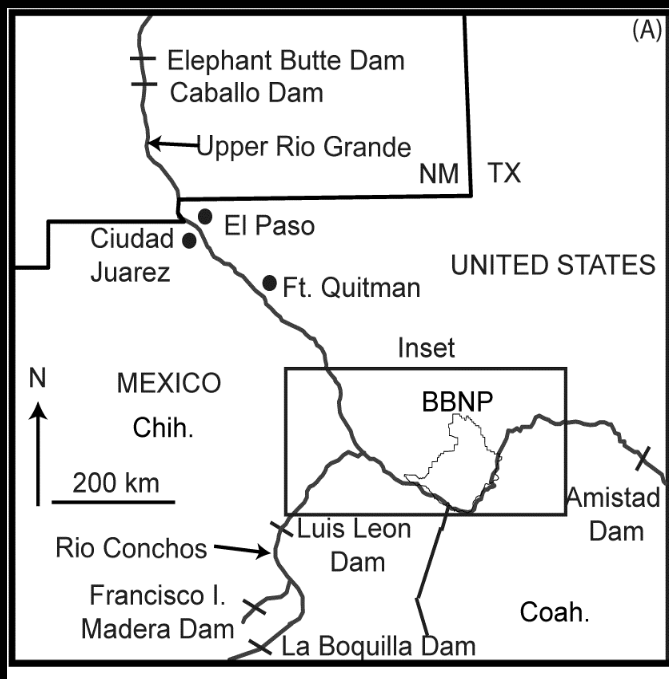

Biology
Recommendations
Hydrology/Geomorph.
Water Quality

Historic Hydrology

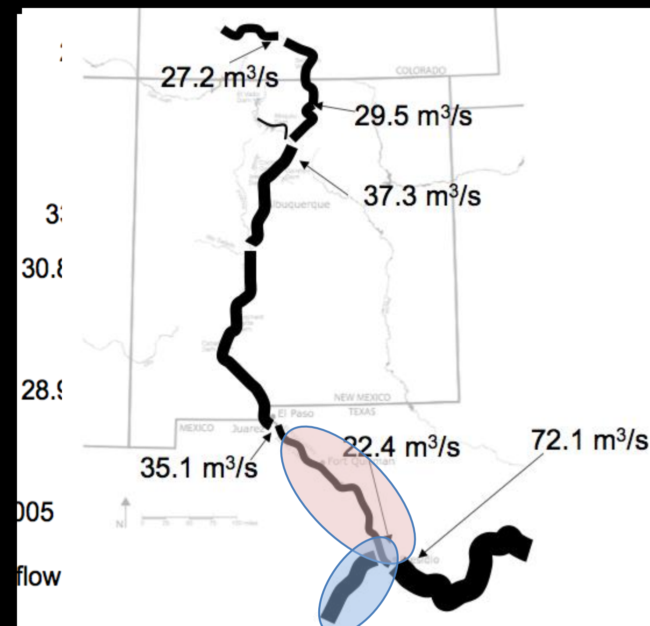
Prior to 1915



Historic Reductions in Stream Flow



1995-2005



Historic Geomorphic Context

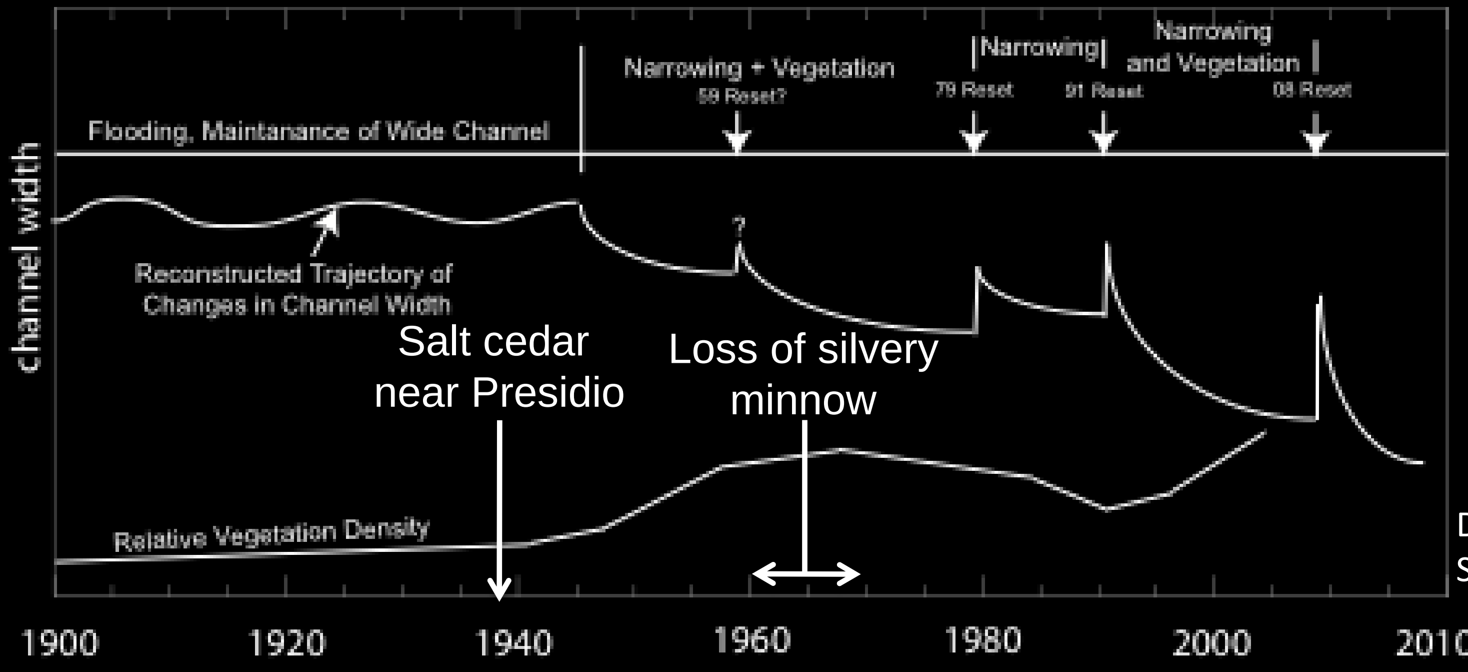
Upstream Unsound Parks Reach - Big Bend National Park

Historic Geomorphic Context – Parks Reach

1945

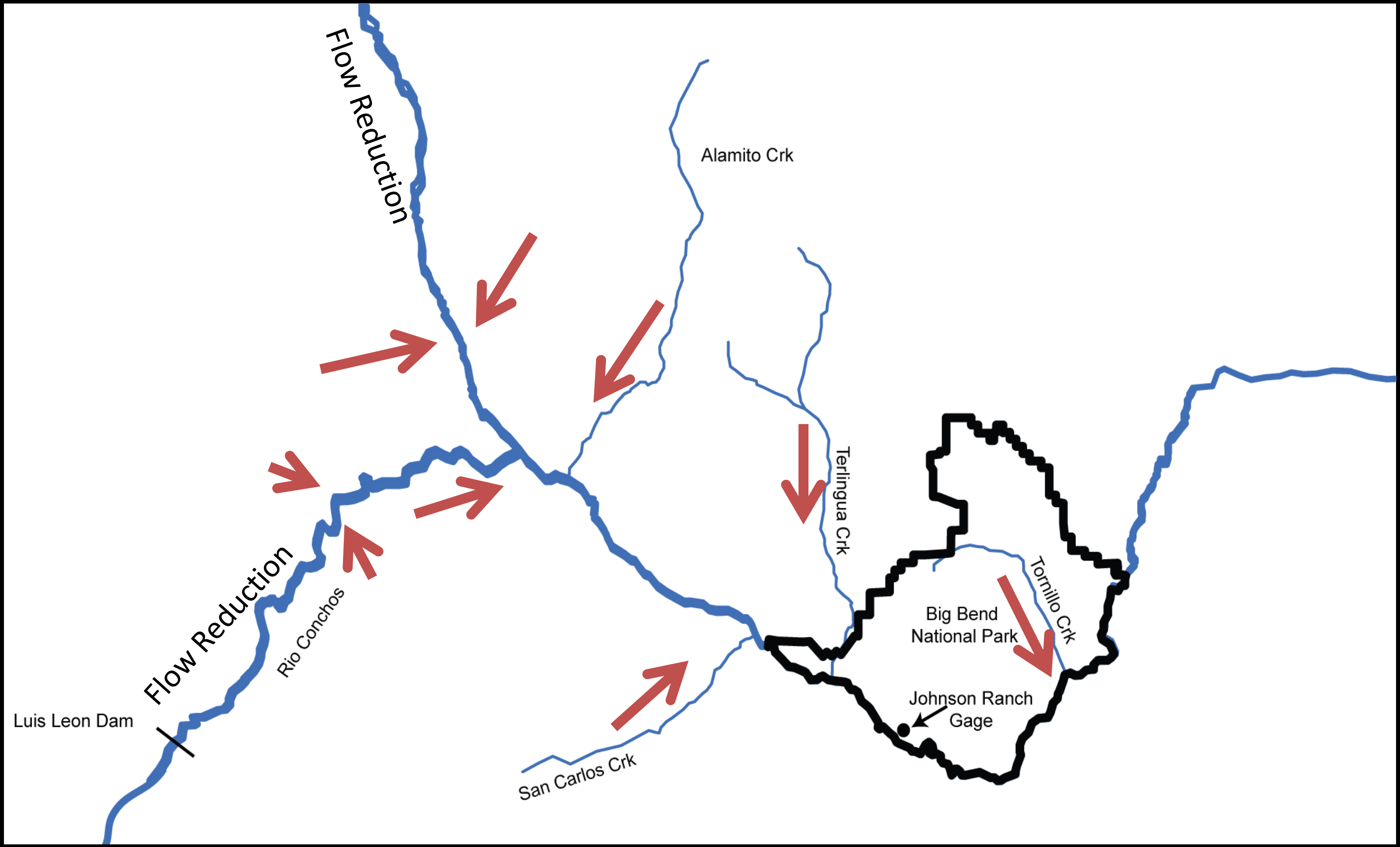
2008

2009



Dean and
Schmidt 2011

Sediment Inputs

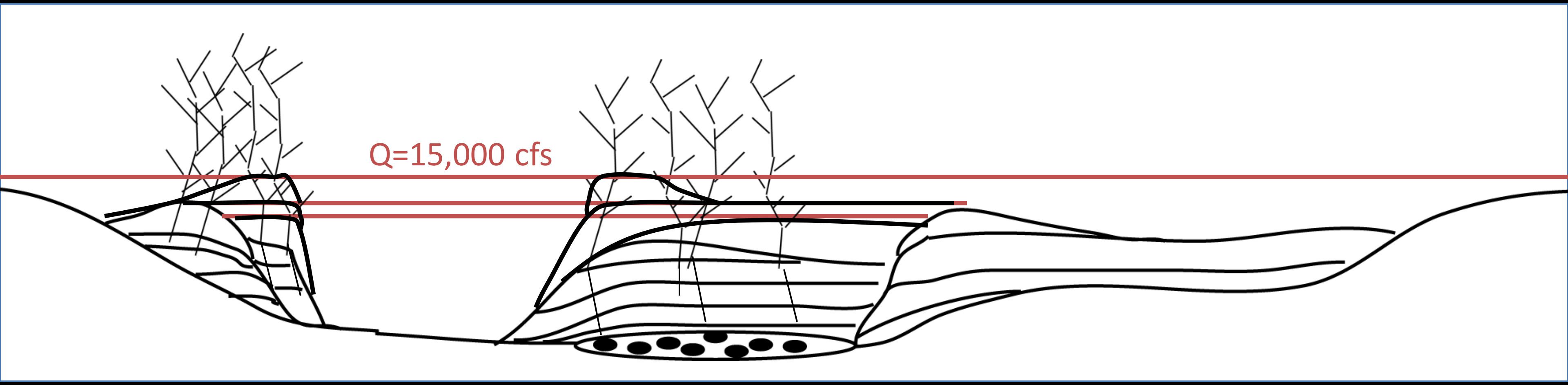


Geomorphic change associated with short duration of flash floods

- Channel narrowing/vertical floodplain accretion caused by high sediment loads during overbank flooding

- Dense Vegetation increases sedimentation

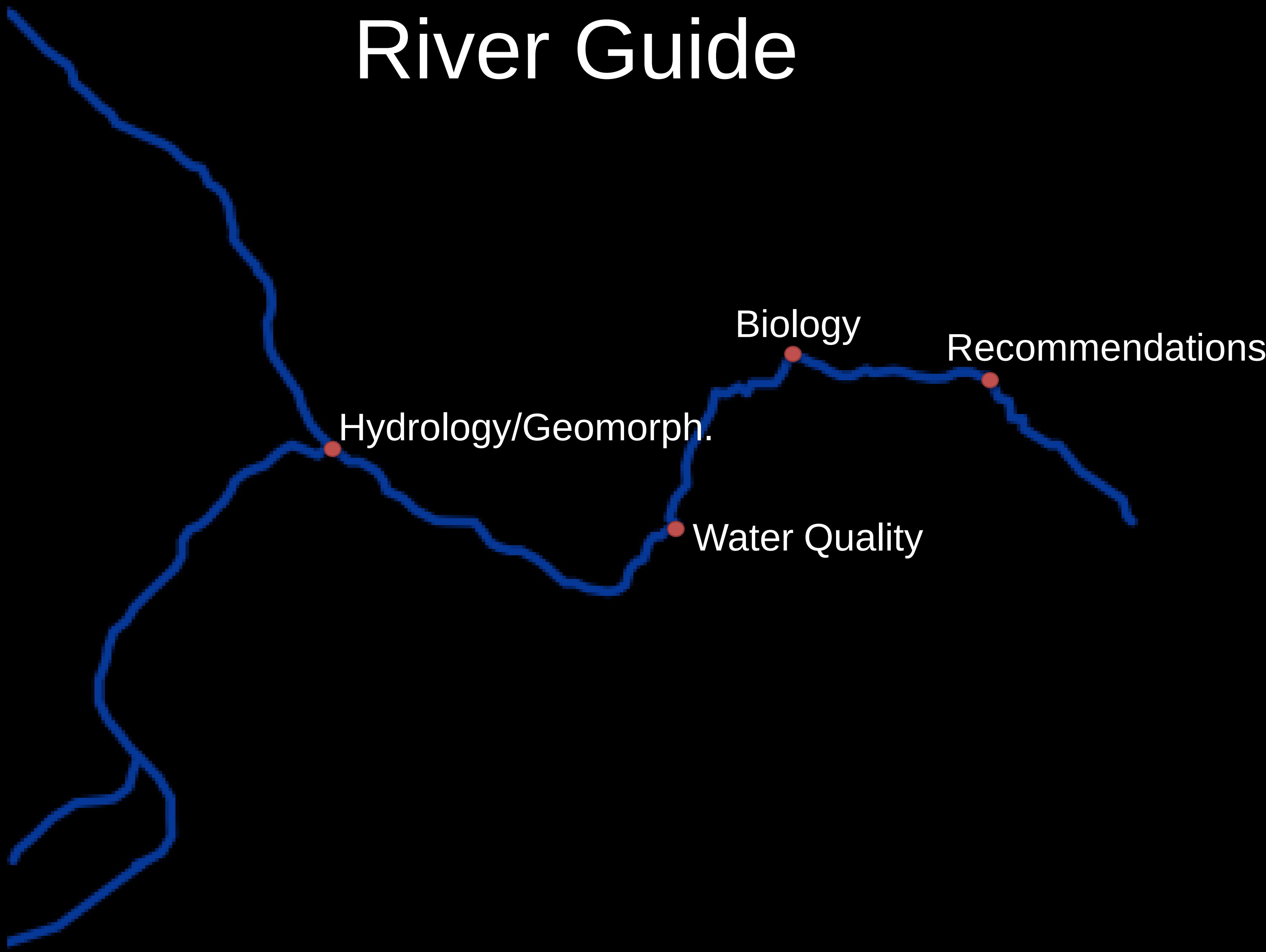
Dean and Schmidt, 2011



Take home point: Large, long duration floods “reset” the channel to a wider, shallower geomorphic form – good for aquatic habitat diversity

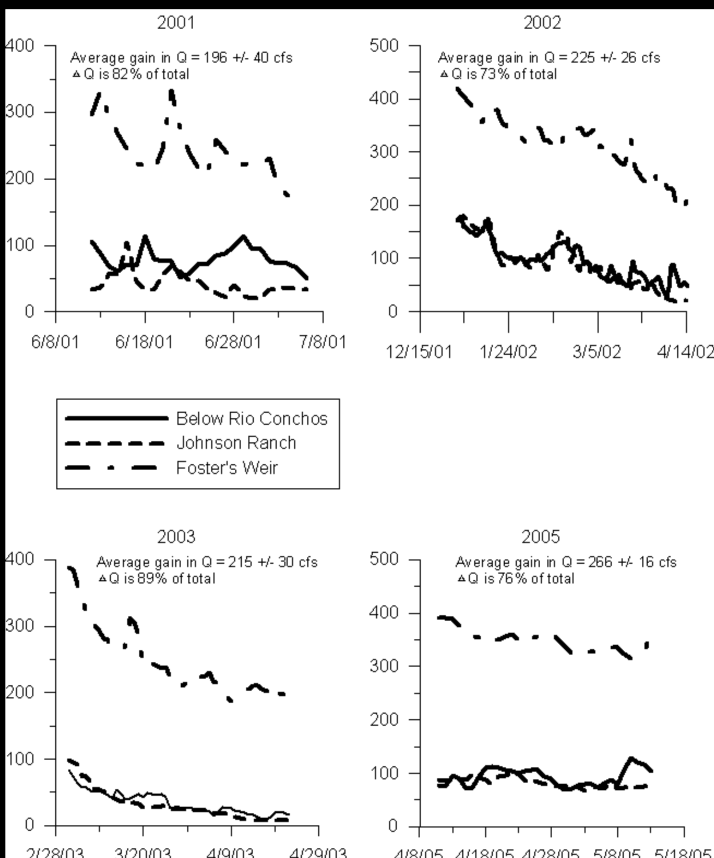
Short duration, sediment rich, flash floods cause channel narrowing and vertical floodplain accretion. Negatively affects aquatic habitat availability

River Guide

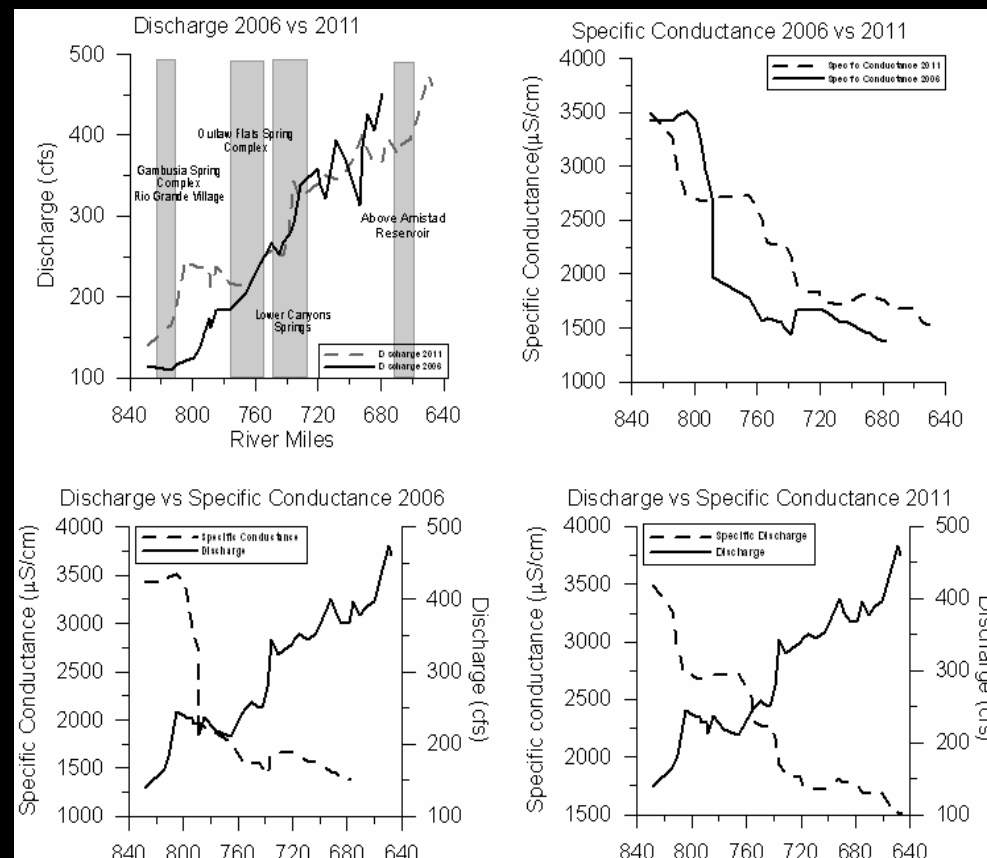

Biology
Recommendations
Hydrology/Geomorph.
Water Quality

Water Quality - Effects of Groundwater at low flows

Downstream increases in Discharge



Increases in discharge ameliorate high salinity

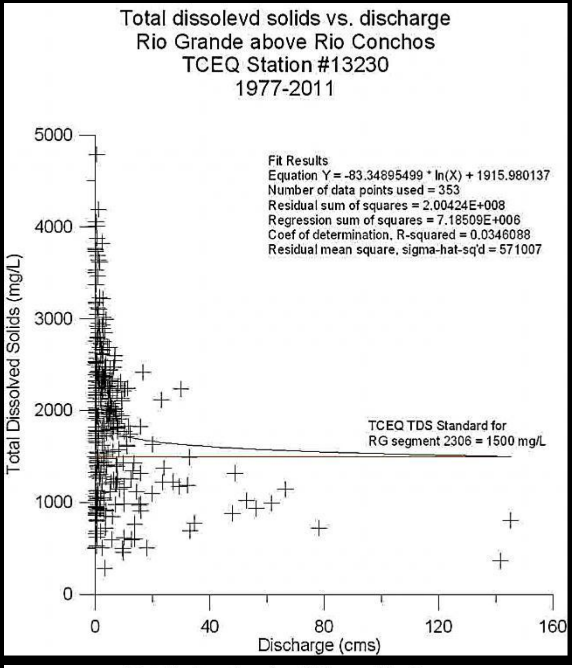


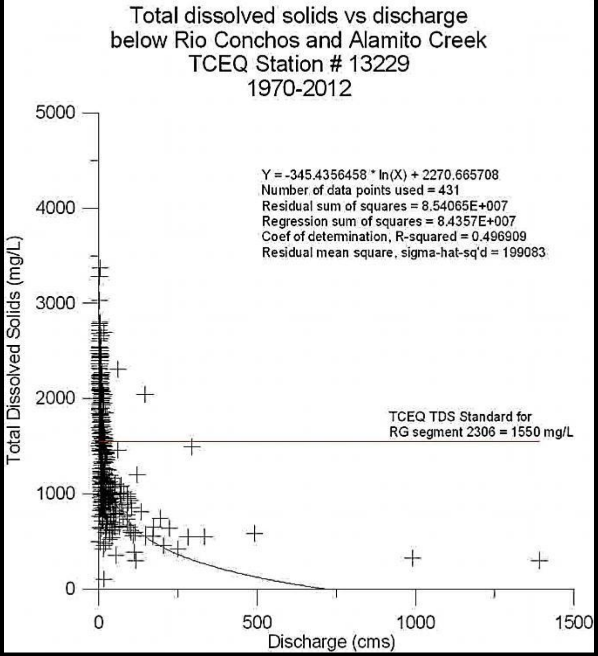
Water Quality – Total Dissolved Solids

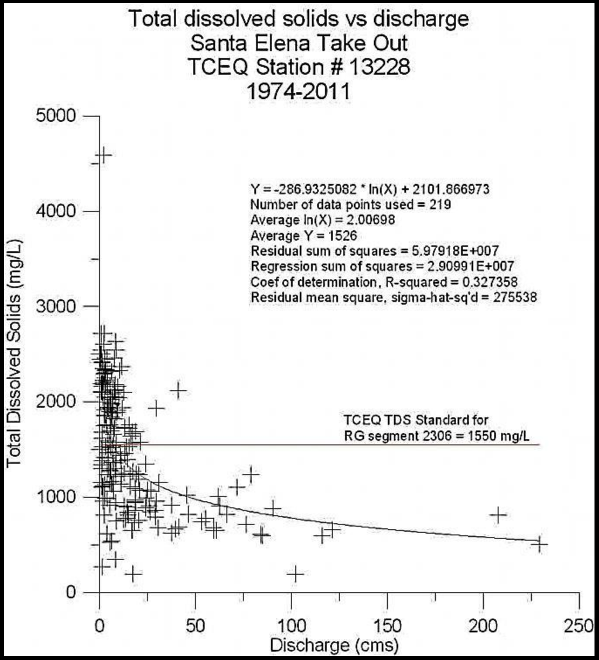
At all TCEQ monitoring sites, there is a decrease in TDS with increasing discharge.

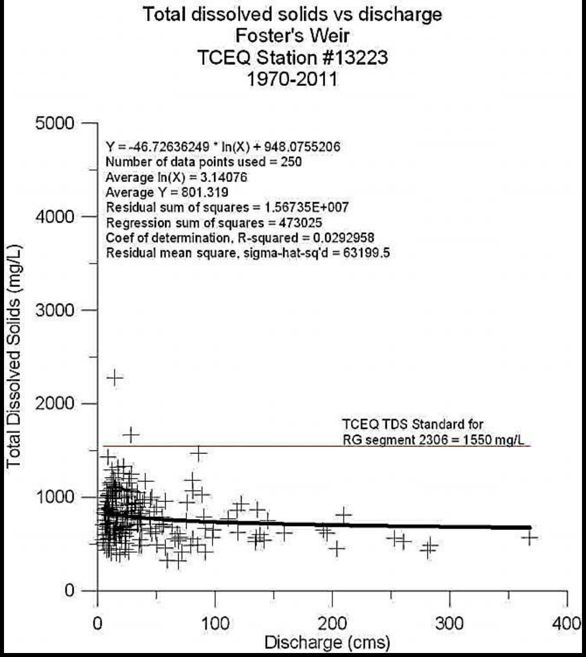
TDS is often above acceptable limits at low discharges in the unsound parks reach

At the Foster's weir gage, in the sound lower canyons reach, TDS is significantly less.

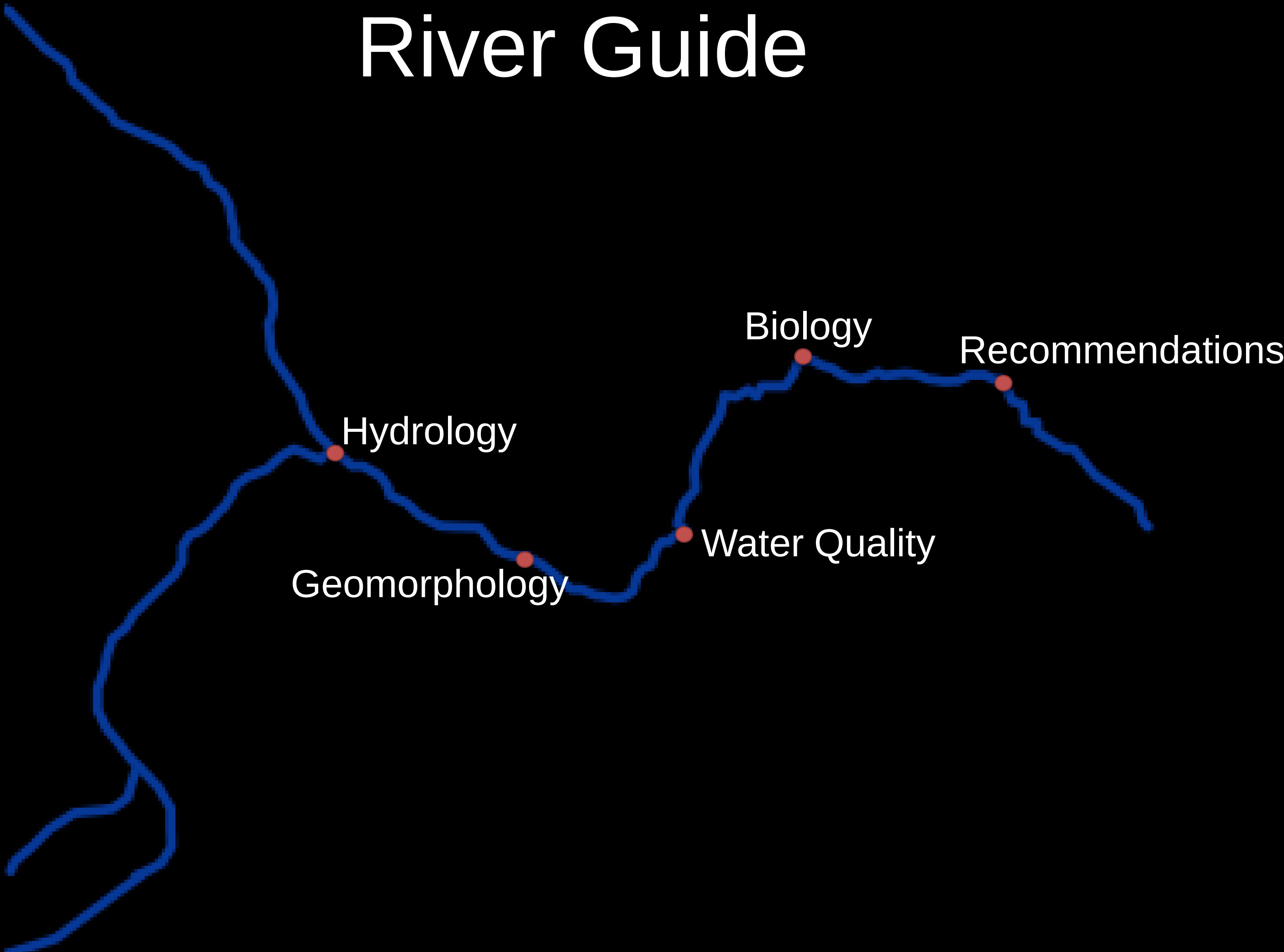








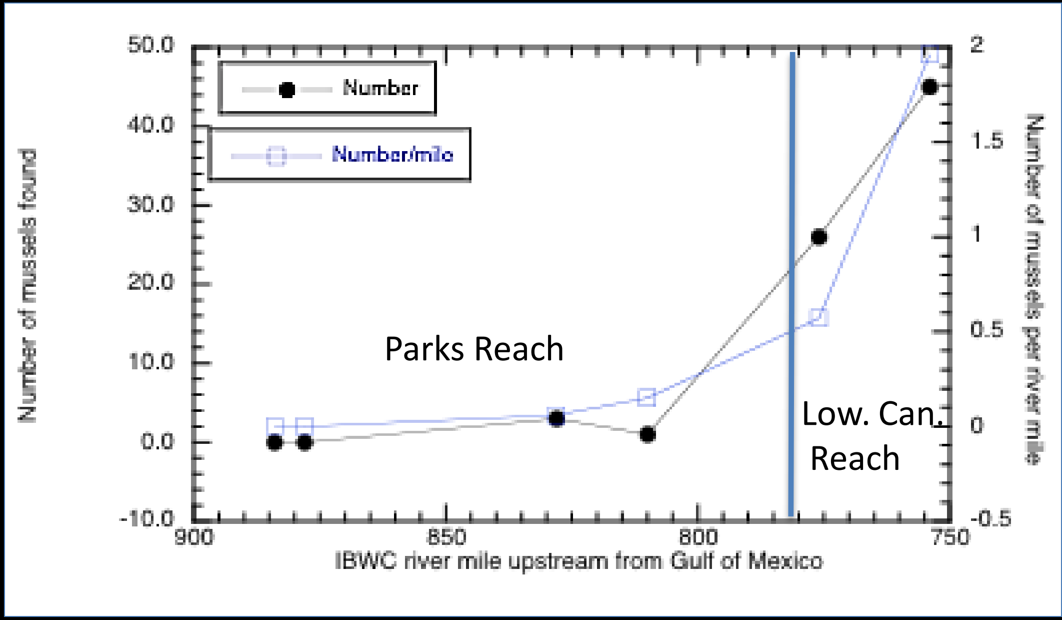
River Guide


Biology
Recommendations
Hydrology
Water Quality
Geomorphology

Biological Overlay

2005 Muscle surveys - Increasing abundance and species downstream in Lower Canyons Reach

Muscle surveys



Biological Overlay

Porter and Longley, 2011 – Study of algal communities downstream from Presidio

- Presidio to Castolon (Parks Reach) – Brackish water species
- Castolon to La Linda (Parks Reach) – Transition zone dominated by algal communities indicating mesotrophic or eutrophic conditions.
- Downstream of La Linda (Lower Canyons Reach) – Algal assemblages indicated improving water quality.
- Findings congruent with the TCRP assessment in 2008 that lists the upper segments as impaired for contact recreation.

River Guide


Biology
Recommendations
Hydrology
Water Quality
Geomorphology

Recommendations.

- Step 1 – Run HEFR analyses
  - •Pre-1967 hydrology for Below Rio Conchos and Johnson’s Ranch gages– the last time the Parks reach was believed to be sound.
  - •Full period of record for Foster’s Weir (1962-2009) – Currently deemed sound
  - •Full period of record for Alamito and Terlingua Creeks (1932-2009) – Currently deemed sound.

- Step 2 - Can we use water quality and biological overlays to adjust subsistence and base-flow recommendations for Below Rio Conchos and Johnson’s Ranch gages?

- Step 3 - Use Geomorphology overlay to adjust high flow pulse and overbank flow recommendations for Below Rio Conchos and Johnson’s Ranch gages.

Subsistence and Base Flow Recommendations (Below Rio Conchos and Johnson's Ranch)

- Although biology and water quality indicate that the there are unsound ecological conditions at low flows, there is very little understanding on what flows are needed to improve these conditions.

- 1 exception - Initial HEFR run at Johnson's Ranch - subsistence flow 28 cfs during spring months. Recent field work conducted by the USGS and Texas Parks and Wildlife found that a flow of this discharge is inadequate to maintain longitudinal connectivity (Saunders, pers. comm). Thus, subsistence flow numbers for Spring were increased to 40 cfs.

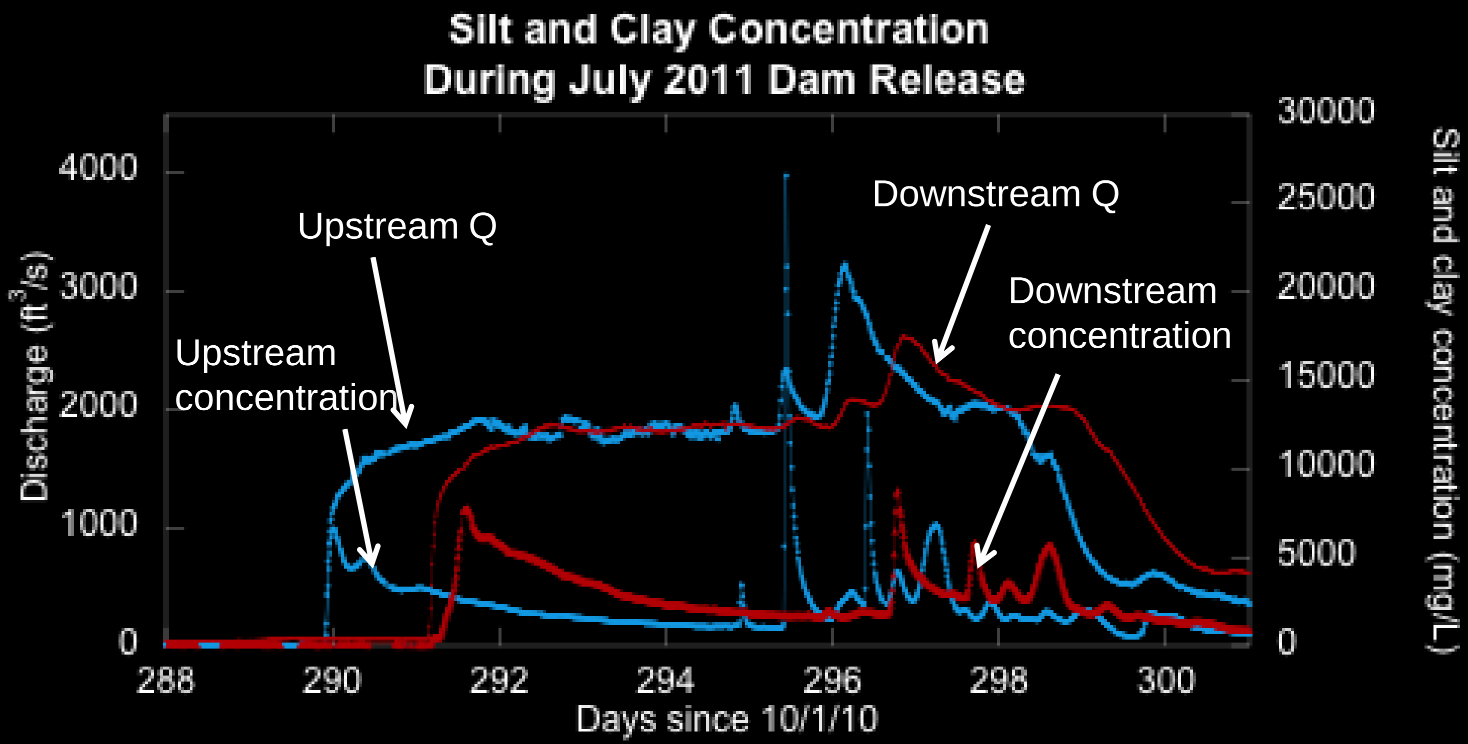
- All other subsistence and base flow numbers determined from pre-1967 HEFR analyses at these gages.

High Flow Pulses and Overbank Flows Geomorphology Overlay

- Current management goal - Limit the rate and magnitude of channel narrowing between reset events
  - Prevent the loss of essential riverine habitat (e.g. backwaters and side channels).
- Overbank flows cause vertical floodplain accretion and channel narrowing – negative effects for aquatic habitat.

Sediment management problem – Is it possible to more efficiently convey sediment downstream in order to maintain channel width and complexity?

What we can learn from 1 moderate magnitude, long duration flow, using real-time suspended sediment monitoring



Preliminary data from Utah State University and USGS Grand Canyon Research and Monitoring Center

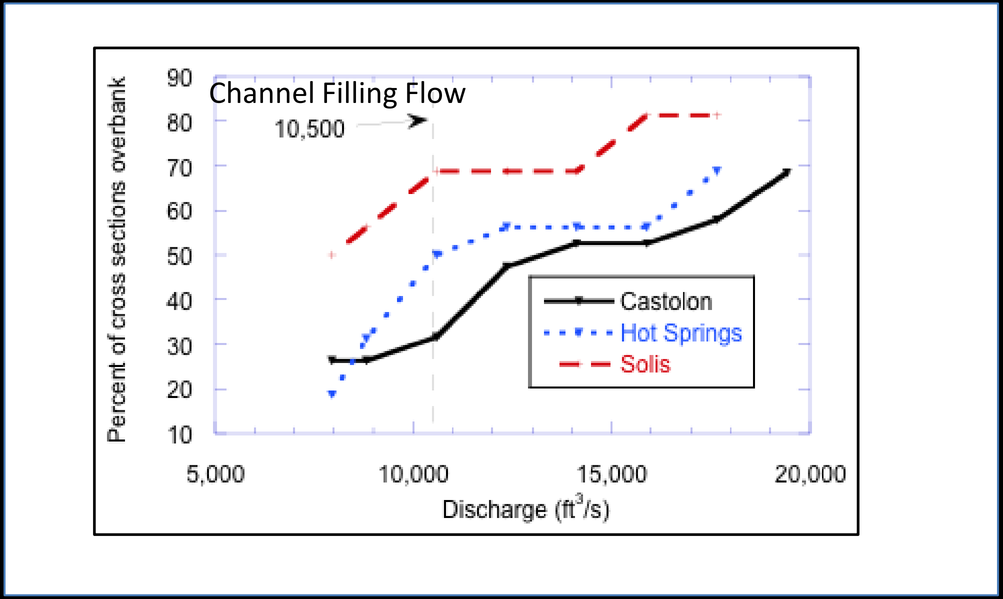
What we can learn from 1 long-duration flow

• Long-duration, moderate floods appear to have the ability to export fine sediment

• How do we maximize fine sediment export in order to limit channel narrowing?

•Maximize the duration, and the shear stress on the bed and banks without going overbank! Fill the channel for the longest time possible. What is the channel filling discharge?

1-dimensional hydraulic modeling to determine the magnitude of channel filling flow



Ongoing Work, Utah State University

Final Recommendations

- Alamito Creek, Terlingua Creek, and Rio Grande at Foster’s weir – HEFR outputs based on full period of record

- Rio Grande below Rio Conchos, and Johnson’s Ranch:

    - Pre-1967 HEFR analyses for subsistence and base flows with a lower limit of 40 cfs for subsistence.

    - High flow pulses = channel filling flows of 10,500 cfs for a minimum of 5 days annually

    - No overbank flow recommendations because of detrimental geomorphic effects.

    - Channel resetting flows, greater than 35,000 cfs, should occur once every 10 years (Dean and Schmidt 2011).

Alamito Creek

Overbank Flows	Qp: 2,469 ft^3/s with Average Frequency 1 per 5 years Regressed Volume is 9,996 Regressed Duration is 6		
High Flow Pulses	Qp: 1,459 ft^3/s with Average Frequency 1 per 2 years Regressed Volume is 5,763 Regressed Duration is 6		
High Flow Pulses	Qp: 915 ft^3/s with Average Frequency 1 per year Regressed Volume is 3,535 Regressed Duration is 5		
High Flow Pulses	Qp: 2 ft^3/s with Average Frequency 1 per 2 seasons Volume is 1,448 Duration is 4	Qp: 484 ft^3/s with Average Frequency 1 per 2 seasons Volume is 1,448 Duration is 4	Qp: 1,250 ft^3/s with Average Frequency 1 per 2 seasons Volume is 5,175 Duration is 6
High Flow Pulses		Qp: 226 ft^3/s with Average Frequency 1 per season Volume is 648 Duration is 4	Qp: 675 ft^3/s with Average Frequency 1 per season Volume is 2,700 Duration is 6
Base Flows (ft^3/s)	1.8(49.5%)	1.8(36.9%)	1.8(49.4%)
Base Flows (ft^3/s)	1.4(67.5%)	1.4(47.4%)	1.4(58.5%)
Base Flows (ft^3/s)	1.1(85.1%)	1.1(69.5%)	1.1(74.9%)
Subsistence Flows (ft^3/s)	0.71(97.8%)	0.71(87.0%)	0.71(87.8%)
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct
	Winter	Spring	Monsoon

Terlingua Creek

Overbank Flows	Qp: 5,933 ft^3/s with Average Frequency 1 per 5 years Volume is 18,999 Duration is 7		
High Flow Pulses	Qp: 3,673 ft^3/s with Average Frequency 1 per 2 years Volume is 11,913 Duration is 7		
High Flow Pulses	Qp: 2,370 ft^3/s with Average Frequency 1 per year Regressed Volume is 7,760 Regressed Duration is 6		
High Flow Pulses	Qp: 49 ft^3/s with Average Frequency 1 per 2 seasons Volume is 241 Duration is 5	Qp: 1,621 ft^3/s with Average Frequency 1 per 2 seasons Volume is 5,261 Duration is 5	Qp: 3,002 ft^3/s with Average Frequency 1 per 2 seasons Volume is 9,961 Duration is 7
High Flow Pulses	Qp: 6 ft^3/s with Average Frequency 1 per season Volume is 111 Duration is 4	Qp: 950 ft^3/s with Average Frequency 1 per season Volume is 3,079 Duration is 5	Qp: 2,041 ft^3/s with Average Frequency 1 per season Volume is 6,890 Duration is 7
High Flow Pulses		Qp: 389 ft^3/s with Average Frequency 1 per season Volume is 1,261 Duration is 4	Qp: 1,130 ft^3/s with Average Frequency 1 per season Volume is 3,899 Duration is 6
Base Flows (ft^3/s)	2.8(47.0%)	2.8(42.3%)	2.8(66.1%)
Base Flows (ft^3/s)	2.5(58.6%)	2.5(53.3%)	2.5(73.8%)
Base Flows (ft^3/s)	2.1(75.4%)	2.1(67.3%)	2.1(82.7%)
Subsistence Flows (ft^3/s)	1.4(96.2%)	1.1(96.7%)	1.1(97.7%)
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct
	Winter	Spring	Monsoon

Rio Grande at Foster's Weir – Lower Canyon's Reach

Overbank Flows	Qp: 24,190 ft^3/s with Average Frequency 1 per 5 years Volume is 514,209 Duration is 28		
High Flow Pulses	Qp: 12,710 ft^3/s with Average Frequency 1 per 2 years Volume is 255,443 Duration is 17		
High Flow Pulses	Qp: 9,394 ft^3/s with Average Frequency 1 per year Volume is 3180,801 Duration is 14		
High Flow Pulses		Qp: 6,145 ft^3/s with Average Frequency 1 per 2 seasons Volume is 100,385 Duration is 9	Qp: 11,650 ft^3/s with Average Frequency 1 per 2 seasons Volume is 258,289 Duration is 16
High Flow Pulses		Qp: 4,344 ft^3/s with Average Frequency 1 per season Volume is 69,770 Duration is 7	Qp: 7,451 ft^3/s with Average Frequency 1 per season Volume is 146,598 Duration is 11
Base Flows (ft^3/s)	883(34.1%)	823(39.9%)	975(58.7%)
Base Flows (ft^3/s)	682(55.6%)	599(54.5%)	735(71.3%)
Base Flows (ft^3/s)	540(76.3%)	449(68.4%)	530(82.8%)
Subsistence Flows (ft^3/s)	331(98.3%)	301(90.1%)	290(96.4%)
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct
	Winter	Spring	Monsoon

RG below Rio Conchos

	Winter	Spring	Monsoon
Channel Resetting Flows	Qp: Greater than 35,000 ft^3/s with Average Frequency of 1 per 10 years		
Overbank Flows	No flow recommendations		
High Flow Pulses	Qp: 10,500 ft^3/s with Average Frequency 1 per year Volume is 273,397 Duration is 5		
Base Flows (ft^3/s)	901 (38.2%)	675 (32.4%)	816 (60.6%)
	590 (58.8%)	348 (50.5%)	537 (72.8%)
	367 (78.0%)	227 (65.3%)	310 (84.5%)
Subsistence Flows (ft^3/s)	95 (98.6%)	52 (89.6%)	80 (96.8%)
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct
	Winter	Spring	Monsoon

RG at Johnson's Ranch

	Winter	Spring	Monsoon
Channel Resetting Flows	Qp: Greater than 35,000 ft^3/s with Average Frequency of 1 per 10 years		
Overbank Flows	No flow recommendations		
High Flow Pulses	Qp: 10,500 ft^3/s with Average Frequency 1 per year Volume is 273,397 Duration is 5		
Base Flows (ft^3/s)	788 (43.4%)	469 (33.8%)	643 (61.8%)
	509 (62.8%)	258 (54.7%)	406 (74.6%)
	339 (81.3%)	168 (71.1%)	228 (85.8%)
Subsistence Flows (ft^3/s)	N/A	40 (91.3%)	40 (97.5%)
	Nov Dec Jan Feb	Mar Apr May Jun	Jul Aug Sep Oct
	Winter	Spring	Monsoon

Reset flows determined
From Dean and Schmidt 2011

Critical Adaptive Management Needs

Geomorphology – need to further understand sediment dynamics during different types of high flows – i.e.Dam releases from Conchos, flash floods from tributaries

Habitat – need to determine habitat availability during subsistence and base flows for critical species – how does habitat change during periods of channel narrowing and during channel reset events

Water Quality – Continuous (15-min) water quality data has been collected at Castolon and Rio Grande Village since 2007. Need to conduct comprehensive analysis of these data to further inform trends during different portions of the flow regime.

Riparian Vegetation – How do native and non-native species (salt cedar and giant cane) respond during tributary flash floods and long duration high flow pulses. Which types of flows benefit the native riparian community the best, and when do they occur?

Upper Rio Grande Acknowledgements

The Upper Rio Grande Basin & Bay Expert Science Team respectfully and gratefully acknowledge the invaluable technical and logistical support provided by the following organizations and very capable individuals:

- U.S. Geological Survey Grand Canyon Monitoring and Research Center_– Jack Schmidt, Ronald Griffiths, and Thomas Sabol
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- Texas AgriLife Research
- Texas Agrilife Extension Service
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